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**Carlton**

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(54) **FRUIT HARVESTING APPARATUS**

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(76) Inventor: **James P. Carlton**, 1035 N. Florida Ave., Wauchula, FL (US) 33873

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(\* ) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

*Primary Examiner*—Robert E. Pezzuto  
(74) *Attorney, Agent, or Firm*—Terry M. Sanks, Esq.;  
Beusse Brownlee Bowdoin & Wolter, P.A.

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(57) **ABSTRACT**

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A harvesting apparatus for dislodging produce from trees comprising a support structure, a boom vertically placed where a first end is connected to the support structure, a positioning apparatus to position a second end of the boom radially from the first end, horizontal posts connected to the boom wherein a first post is positioned above a second post, crank arm rotatably connected between the horizontal posts along an axis where the crank arm has a plurality of elbows, one of a plurality of spools rotatably attached to the crank arm at each respective elbow whereby each spool is free to rotate axially, a plurality of wands axially attached to each spool and spaced around each spool, and a rotating apparatus for rotating the crank arm about its axis.

(51) **Int. Cl.**<sup>7</sup> ..... **A01D 46/24**

(52) **U.S. Cl.** ..... **56/330; 56/328.1**

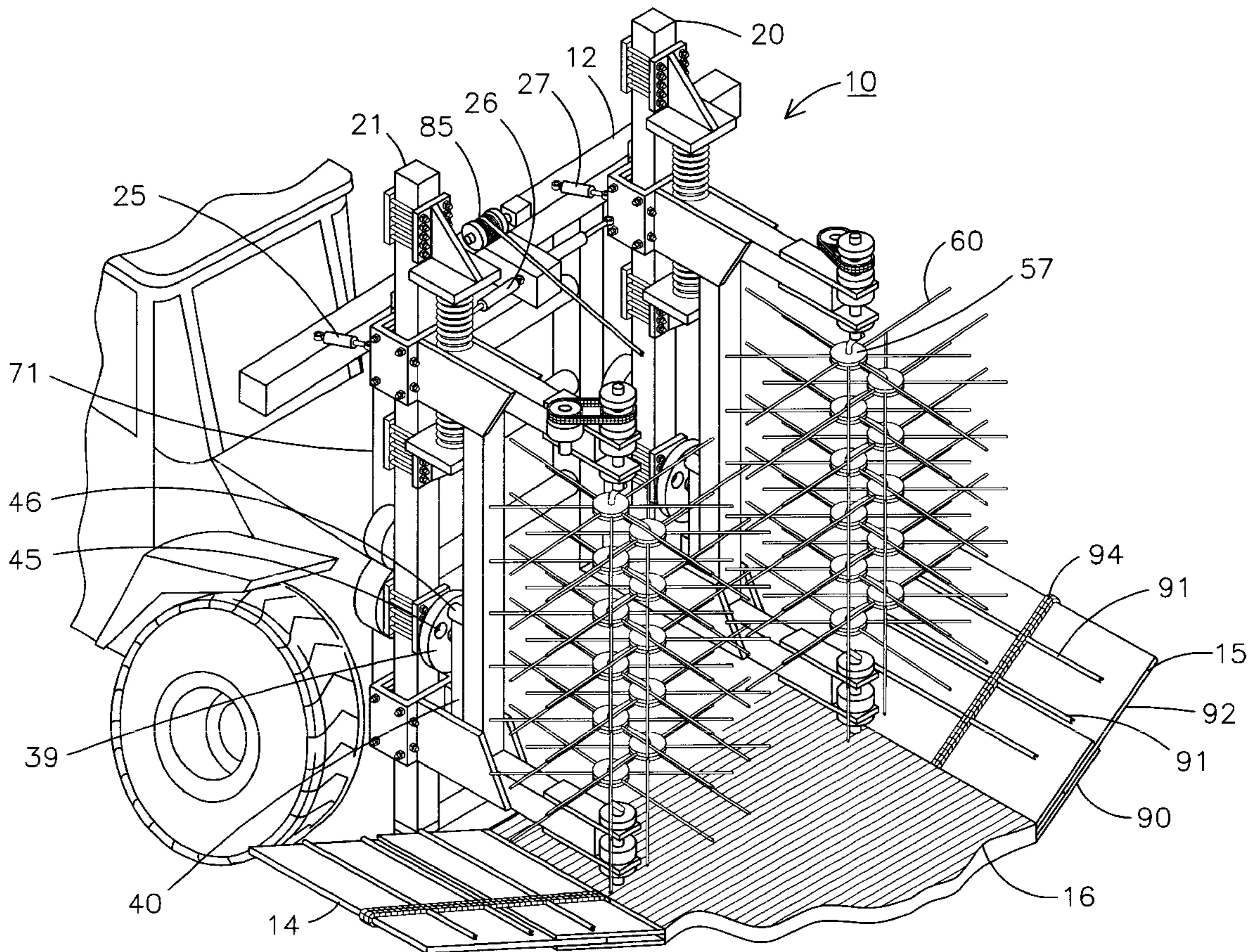
(58) **Field of Search** ..... 56/328.1, 329, 56/330, 331, 340.1, 15.1, 15.2, 15.7, 15.8, DIG. 19

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**24 Claims, 6 Drawing Sheets**



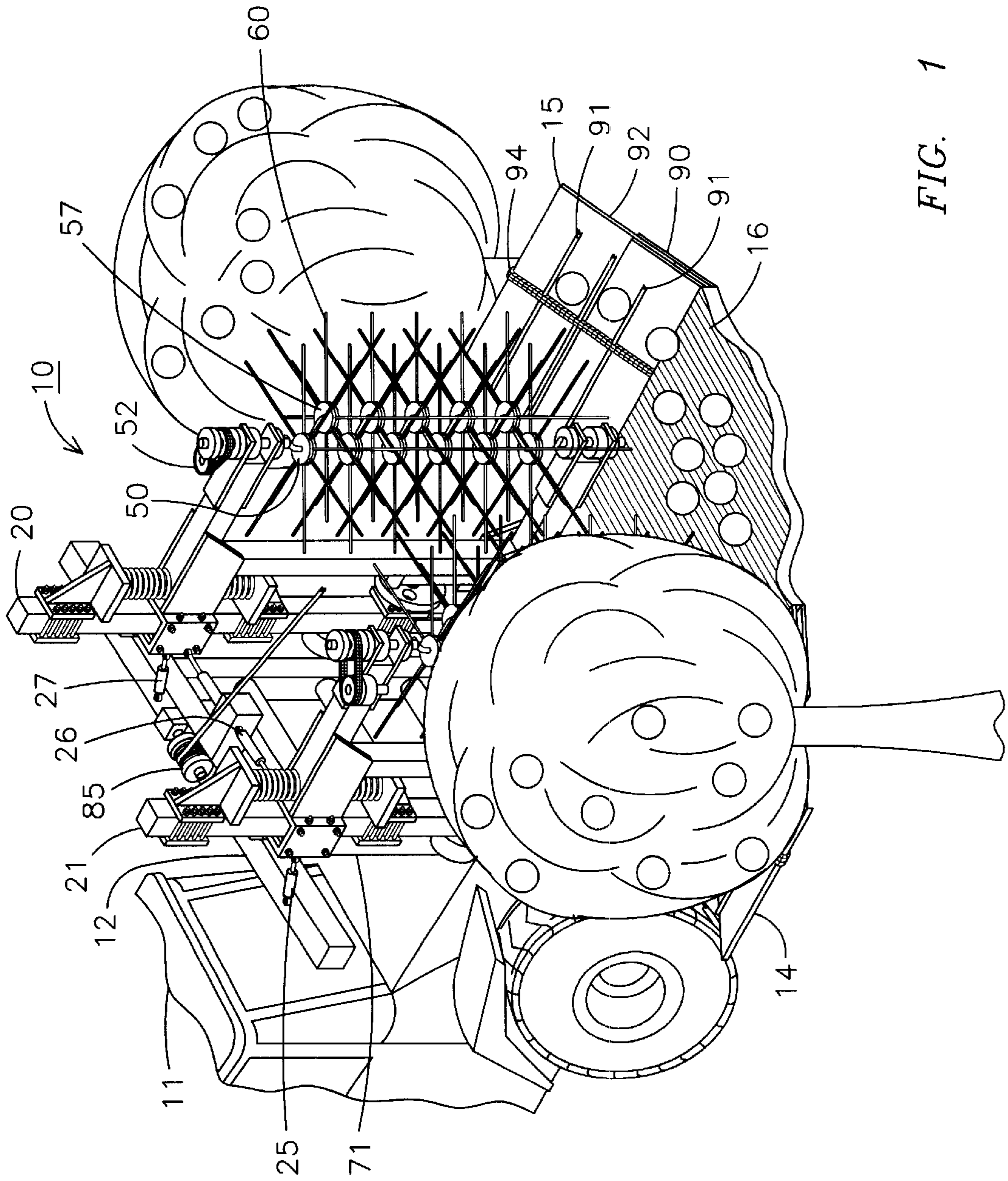


FIG. 1

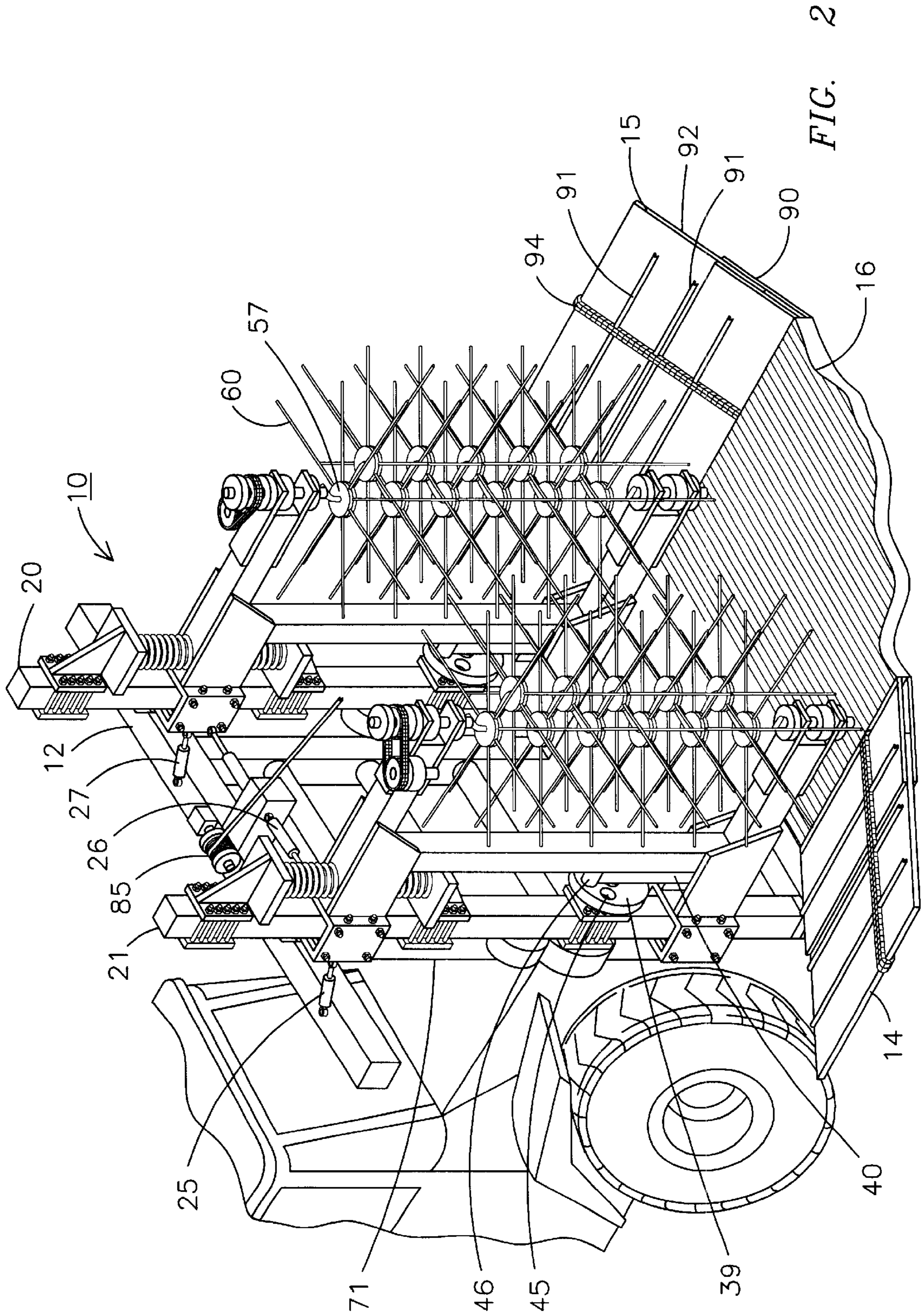


FIG. 2

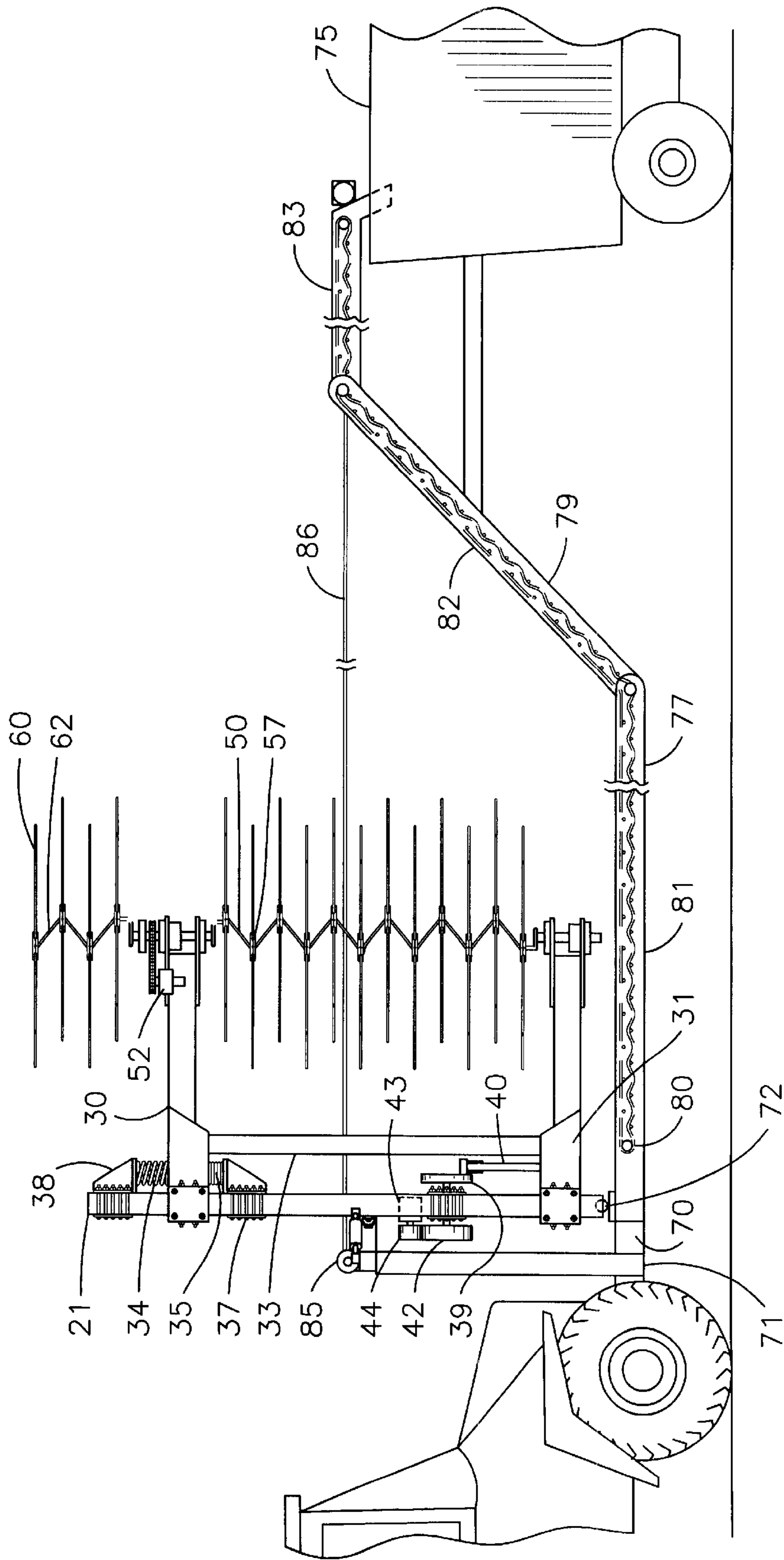


FIG. 3

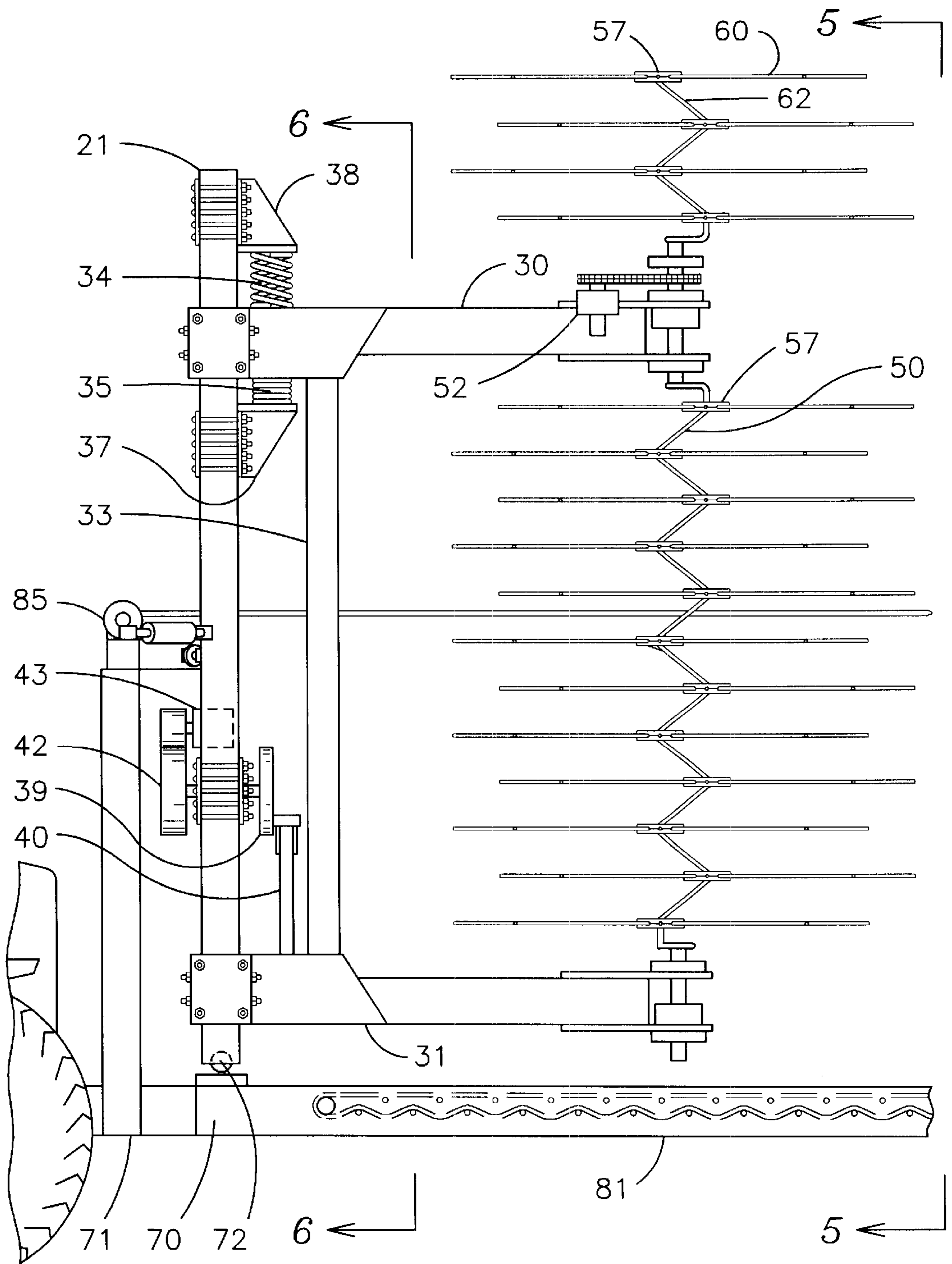


FIG. 4

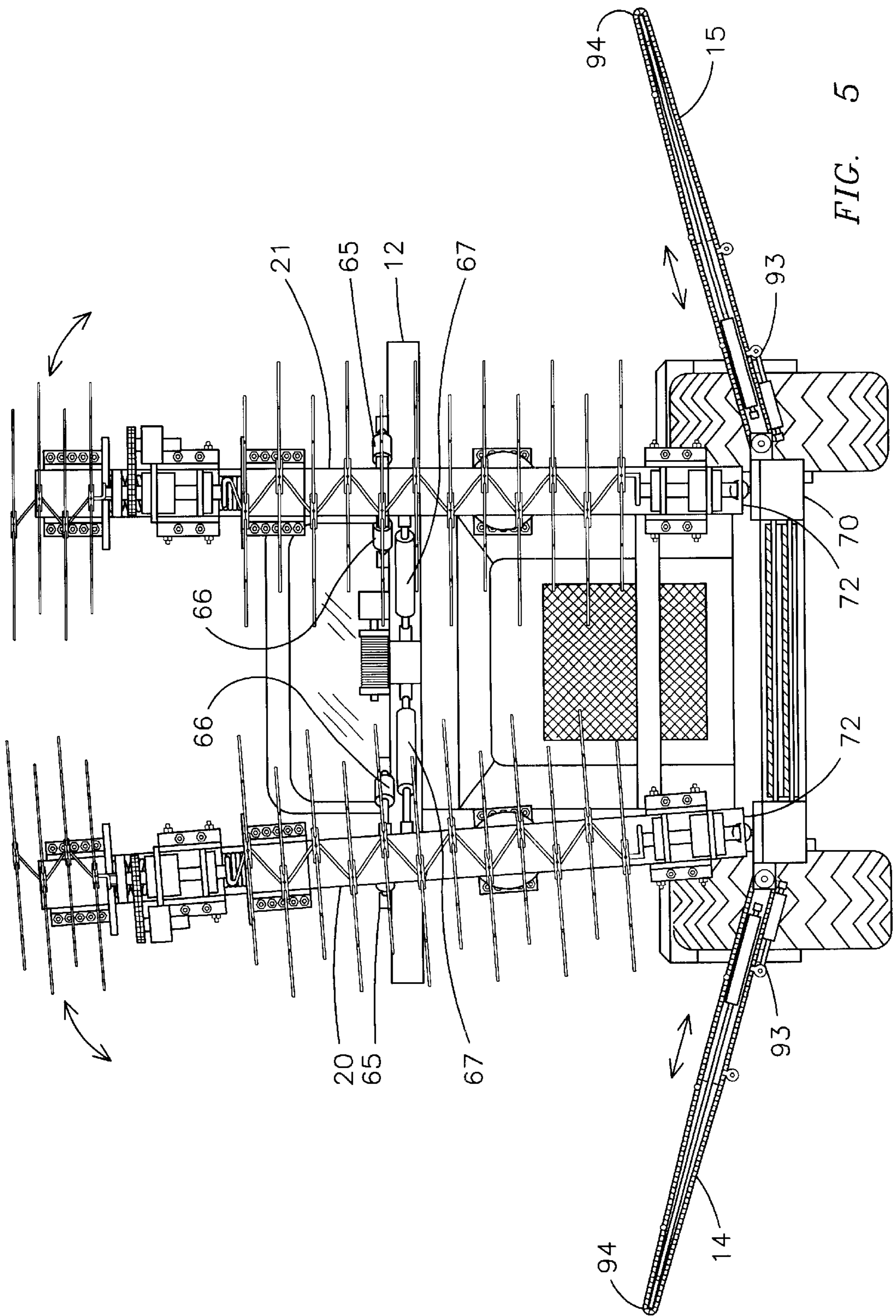


FIG. 5

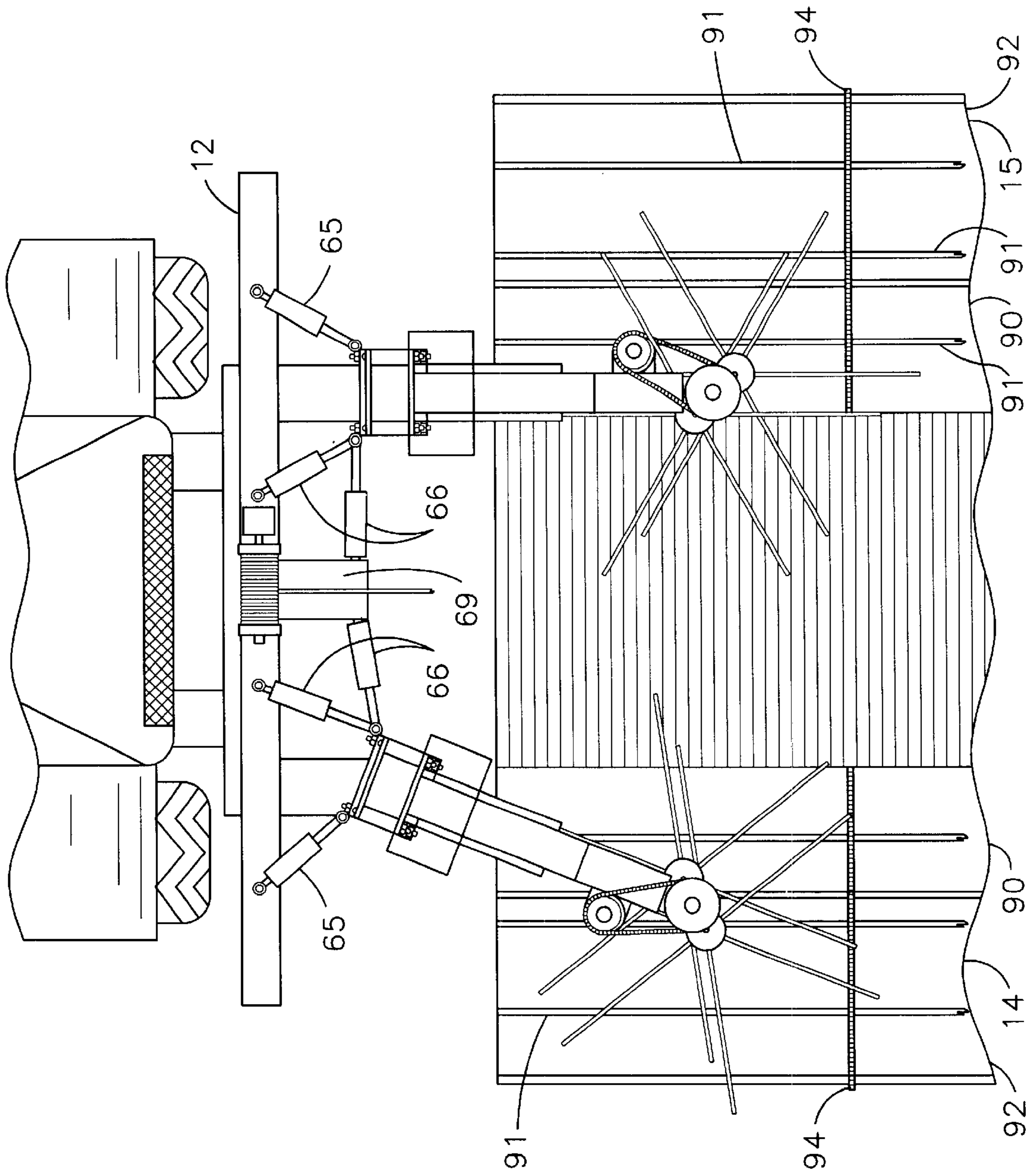


FIG. 6

## FRUIT HARVESTING APPARATUS

## BACKGROUND OF THE INVENTION

The present invention relates to a produce harvesting apparatus and method, and more specifically to an apparatus for removing fruit from a canopy of a tree where wands inserted into the canopy are not physically held in place but which freely move in the canopy as a result of resistance encountered by the foliage of the canopy while the wands are actuated vertically and horizontally.

Various approaches have been developed to harvest produce from trees, such as citrus and other fruit, with the intention of efficiently removing the fruit while not damaging the trees. While it is believed that some methods have included shaking the trunks of the trees, others involve inserting stationary rods into a tree's canopy and vibrating or rotating them in some fashion. It is further believed that none of these devices have been fully successful in picking enough fruit so that the excess fruit left must be picked by hand, while at the same time minimizing damage done to the trees. In several cases, wands, which are inserted into the canopy, are connected to devices that rotate the wands through the canopy. The wands are fixed so that they are not free to move in the canopy as a result of resistance encountered by the foliage. It is also believed that damage to the trees occurs because of the fixed positioning of the wands. For example, it is believed that U.S. Pat. Nos. 3,522,696, and 4,860,529 disclose wands that are fixed to a component which rotates the wands through the canopy and may result in damage to the tree. Another limitation in these patents is the inability to adjust the wands to a desired amount of penetration into the canopy.

In addition to reducing damage to fruit trees, another desire in harvesting fruit is to reduce the time it takes to harvest fruit. For example, U.S. Pat. No. 5,946,896 is believed to disclose a self contained, self propelled fruit harvester which utilizes oscillating removal heads which consist of stationary rods inserted into a tree's canopy that are vibrated to harvest the fruit. This harvester remains in a stationary position while each oscillating removal head is selectively engaged in a single canopy and activated to remove fruit. After the operator determines that the oscillating removal heads have removed enough fruit from this single tree, the oscillating removal heads are disengaged from the canopy and the harvester is free to move to its next tree for harvesting. Thus, it is believed that this harvester is unable to continuously move through a grove of trees at a constant rate as it harvests fruit.

## SUMMARY OF THE INVENTION

It would be advantageous to provide an apparatus capable of harvesting fruit while constantly moving through a field, or grove, of trees. It would also be advantageous to provide an apparatus capable of harvesting more than one tree at a time as it moves through a row of trees where the apparatus can be adjusted to the desired amount of penetration of the wands into the canopy. Additionally, it would also be advantageous to utilize wands for insertion into the canopy where the wands are not rigidly fixed to the apparatus, but are free to move as directed by resistance realized by the wands as a result of contact with foliage of the canopy during operation.

Towards this end, the present invention teaches a harvesting apparatus for dislodging produce from trees comprising a support structure, a boom vertically placed where a first end is connected to the support structure, a means to position

a second end of the boom radially from the first end, horizontal posts connected to the boom wherein a first post is positioned above a second post, crank arm rotatably connected between the horizontal posts along an axis where the crank arm has a plurality of elbows, one of a plurality of spools rotatably attached to the crank arm at each respective elbow whereby each spool is free to rotate axially, a plurality of wands axially attached to each spool and spaced around each spool, and a means for rotating the crank arm about its axis.

In one exemplary example of its operation, as the crank arm turns, each spool is free to rotate its wands through the tree where the rate of rotation for each spool is determined by the turning of the crank arm and resistance encountered by the wands in contact with the tree. This movement, in unison with the propelling of the apparatus, causes fruit to be dislodged.

## BRIEF DESCRIPTION OF THE DRAWINGS

For a better understanding of the present invention, reference may be had to the following detailed description taking in conjunction with the accompanying drawings in which:

FIG. 1 is a perspective drawing of the fruit harvesting apparatus attached to a wheel loader harvesting citrus trees;

FIG. 2 is an exploded view of FIG. 1 without the citrus trees;

FIG. 3 is a cutaway side view of another embodiment of the fruit harvesting apparatus including a separate fruit storage bin;

FIG. 4 is an exploded side view of the other embodiment of the fruit harvesting apparatus;

FIG. 5 is a front view of the fruit harvesting apparatus with the booms vertically placed and the telescoping fruit catcher extended; and

FIG. 6 is a top view of the fruit harvesting apparatus.

## DETAILED DESCRIPTION OF THE INVENTION

FIG. 1 is a perspective drawing of the fruit harvesting apparatus attached to a wheel loader which is harvesting two citrus trees and FIG. 2 is an exploded view of FIG. 1 without the citrus trees. In an exemplary embodiment, the fruit harvesting apparatus 10 consists of a support structure 71, collection conveyor 16 with telescoping side fruit catcher conveyors 14, 15, and two vertical posts or booms 20, 21. The support structure 71 includes a mast 12 and a base 70, which is better illustrated in FIG. 3. A set of hydraulic actuators or positioning cylinders 25, 26, 27 are fixed between the mast 12 and each boom 20, 21. The fruit harvesting apparatus 10 is attached to a wheel loader 11.

FIG. 3 is a cutaway side view of another embodiment of the fruit harvesting apparatus with a mobile, self propelled container or fruit storage bin and FIG. 4 is an exploded side view of the other embodiment of the fruit harvesting apparatus. As further illustrated in these figures, each boom 21 has two horizontal bars or posts, 30, 31 extending from the boom 21, where the horizontal bars 30, 31 extend away from the wheel loader 11. The horizontal bars 30, 31 are connected by a vertical bar 33 so that the horizontal bars 30, 31 move in unison. During operation, the horizontal bars 30, 31 move vertically up and down the boom 21. On the upper horizontal bar 30, air springs 34, 35 are placed above and below the horizontal bar 30 and are connected to attachments 37, 38 extending from the boom 21. The air springs



**34, 35** are placed so as to dampen the actuating and to limit the range of actuating of the horizontal bars **30, 31**.

In one exemplary embodiment, a first wheel or gear **39** with a connecting arm **40** that attaches to the lower horizontal bar **31** is the device which lifts and lowers the horizontal bars **30, 31**. The first wheel **39** abuts against a second wheel or gear **42** which in turn abuts a third wheel or gear **44** that is attached to a hydraulic motor **43**. In one exemplary embodiment the third wheel **44** is a rubber wheel. The hydraulic motor **43** turns the third wheel which turns the second wheel **42** which rotates the first wheel **39**, which in turn lifts and lowers the horizontal bars **30, 31**. The first wheel **39** includes two separate holes **45, 46** for attaching the connecting arm **40**. As better illustrated in FIG. 2, in one exemplary embodiment the holes **45, 46** are spaced so that depending on which hole the connecting arm **40** is connected with, the horizontal bars **30, 31** are lifted either nine inches or six inches from a starting position and then lowered nine inches or six inches. In operation, this movement allows the horizontal bars to be lifted and lowered either 18 inches or 12 inches. In one exemplary embodiment the turning of the wheels **39, 42** is slow and constant where the hydraulic motor **43** turns the wheels **39, 42, 44** at a rate of 40 to 50 revolutions per minute.

As is illustrated in FIGS. 3 and 4, at the end of the lower and upper horizontal bars **30, 31**, a crank arm **50** extends between the horizontal bars **30, 31** and is parallel to the boom **21**. One end of the crank arm **50** is rotatably connected to the underside of the upper horizontal post **30** and the other end is rotatably connected to the upper side of the lower horizontal post **31** where the crank arm rotates along an axis. On top of the upper horizontal post **30** is a hydraulic motor **52** connected to turn the crank arm **50**. Axially free moving spools **57** are positioned at each elbow **58** of the crank arm **50**, and a plurality of wands **60** are extended radially from each spool **57**. In another exemplary embodiment as illustrated in FIGS. 3 and 4, a second crank arm **62** is fixed to the top of the upper horizontal post **30**. The motor **52** also turns the second crank arm **62**. The wands **60** are in the shape of rods, and are made of such materials as plastics, nylon, or other material that will reduce damaging trees, where the wands are flexible in nature.

In one exemplary embodiment as illustrated in FIGS. 1 and 2, four wands **60** extend from each spool **57**. More wands can be extended from each spool. For example, in another exemplary embodiment the crank arm **50** between the horizontal posts **30, 31** holds sixteen spools **57** and sixteen wands **60** are connected to each spool **57**. The crank arm **62** above the upper horizontal post **30** holds four spools **57** with sixteen wands **60** connected to each spool **57**.

FIG. 5 is a front view of the fruit harvesting apparatus with the booms vertically placed and the telescoping fruit catcher extended and FIG. 6 is a top view of the fruit harvesting apparatus. As illustrated in FIGS. 5 and 6, three hydraulic actuators **65, 66, 67** are connected between the booms **21, 22** and the mast **12** to move and control the cantilevering and positioning of each boom **21, 22** radially from the base of the booms **21, 22**. In an exemplary embodiment two of the actuators **65, 66** are connected to a top of the mast **12** and the third actuator **67** is connected to a component **69** extending from the mast **12**. As illustrated in FIGS. 3 through 5, the base of each boom **21, 22** is connected to the base **70** of the support structure **71** by way of a ball joint connection **72**. The ball joint connection **72** in conjunction with the actuators **65, 66, 67** allows each boom **21, 22** to move in a 360 degree radius about the ball joint connection so as to best be positioned to make contact with a canopy of a tree.

As further illustrated in FIG. 3, an additional independently mobile fruit storage bin **75** may be placed in front of the fruit harvesting apparatus for collecting more fruit. As best illustrated in FIGS. 1 and 2, the fruit harvesting apparatus includes a collection conveyor **16** and telescoping fruit catcher conveyors **14, 15** or a three conveyor belt transportation system **14, 15, 16**. The collection conveyor **16** includes a conveyor **77**, such as a potato chain conveyor, to move the fruit from the collection conveyor **16** to the mobile storage bin **75**. The components for the conveyor belt system **77** include a conveyor belt **79** and rollers **80** which guide the belt **79**. The conveyor belt transportation system **77** may be segmented **81, 82, 83** so as to fold or adjust the conveyor system **77** to operate with various sized mobile storage bins **75**. In one exemplary embodiment a first segment **81** is horizontal. A second segment **82** is angled upward away from the booms **20, 21**, and a third segment **83** is horizontal but at a higher height than the first segment **81**. A wrench **85** is located on the mast **12** and is connected via a cable **86** to part of the conveyor system **82** so as to adjust the conveyor system **77** to accommodate various shaped mobile storage bins **75**.

As best illustrated in FIGS. 2, 5, and 6, the collection conveyor **16** includes telescoping fruit catcher sides **14, 15**. In an exemplary embodiment, the telescoping conveyor sides **14, 15** consist of a lower segment **90** which is made of a solid sheet of metal, such as aluminum. The telescoping segment or upper segment **92** is made of a material such as a metal mesh and slides upon the lower segment **90**. Bars **91** extend laterally across upper segment **92** and lower segment **90** and are connected to a chain **94**. As the chain is rotated by a motor (not shown) the bars are passed over the upper **92** and lower **90** segments. A motor (not shown) is operable to extend the upper segment **92** from its starting position under the lower segment **90** to varied lengths. A tension adjuster (not shown) is connected to the chain to adjust slack in the chain based on the telescoping position of the upper segment **92**. Each conveyor side **14, 15** can be lowered and raised by way of a hydraulic actuator **93**.

In one exemplary embodiment, the fruit harvesting apparatus **10** is a stand-alone component that is attached to a multi-use wheel loader **11**. A power unit (not shown) to operate the actuators **65, 66, 67, 93** telescoping fruit catcher catchers **14, 15**, conveyor belt system **77**, motors **43, 52**, and wrench **85** is either integrated into the fruit harvesting apparatus **10** or the power is received from the wheel loader **11**. A control system (not shown) for the actuators **65, 66, 67, 93** is also part of the fruit harvesting apparatus and is easily installed in the wheel loader **11**. In another exemplary embodiment, a control system for the motors **43, 52**, conveyor belt system **77**, and telescoping fruit catcher conveyors **14, 15** is also included. Other embodiments include attaching the fruit harvesting apparatus **10** to a multi-use tractor or some other vehicle to propel the harvesting apparatus **10** through a row of trees, or integrating the harvesting apparatus **10** into a harvesting apparatus-only dedicated self-propelled vehicle.

During one mode of operation, an operator activates the hydraulic actuators **65, 66, 67** to place the booms **20, 21** into position so that the wands **60** on each boom **20, 21** are making contact with tree canopies. The operator will then activate the hydraulic motor **43** connected to the wheels **39, 42** and the hydraulic motors **52** connected to the crank arms **50** to move the horizontal bars **27, 28** up and down on the boom **20, 21** and to turn the crank arms **50, 62** in a circular motion. Each individual spool **57** rotationally oscillates and the flexible wands **60** will freely move to find a place within

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the foliage of the canopy of least resistance. The operator will also extend the telescoping fruit catchers **14, 15** far enough under the canopy to catch fruit as it falls and retract the catchers **14, 15** when a trunk of a tree is in the path of either catcher **14, 15**. While this operation is ongoing, the wheel loader **11** is moving through the rows of trees at a slow, but constant speed where the operator is using the actuators **65, 66, 67** for adjusting the placement of the wands **60** within the canopy as needed. The movement of the wheel loader **11** and resistance encountered by the foliage causes the oscillating wands **60** to rotate through the canopy. This movement along with the lifting and lowering of the wands **60** and rotation of the crank arms collectively causes fruit to dislodge and fall onto one of the three conveyor belts **14, 15, 16**.

In another mode of operation, instead of elevating and lowering the horizontal bars **27, 28**, these components will remain stationary after the wands are inserted into the foliage. Only the crank arms will rotate as the wheel loader **11** slowly moves through a row of trees. The movement of the wheel loader **11**, resistance encountered by the foliage, and rotation of the crank arms will still cause the oscillating wands **60** to rotate through the canopy, causing fruit to dislodge and fall onto one of the three conveyor belts **14, 15, 16**.

While the invention has been described in what is presently considered to be the preferred embodiment, many variations and modifications will become apparent to those skilled in the art. Accordingly, it is intended that the invention not be limited to the specific illustrative embodiment but be interpreted within the full spirit and scope of the appended claims.

What is claimed is:

**1.** A harvesting apparatus for dislodging produce from trees comprising:

- a support structure;
- a boom vertically placed where a first end is connected to said support structure;
- a means to position a second end of said boom radially from said first end;
- horizontal posts connected to said boom wherein a first post is positioned above a second post;
- crank arm rotatably connected between said horizontal posts along an axis where said crank arm has a plurality of elbows;
- one of a plurality of spools rotatably attached to said crank arm at each respective elbow whereby each said spool is free to rotate axially;
- a plurality of wands axially attached to each said spool and spaced around each said spool; and
- a means for rotating said crank arm about its axis.

**2.** The apparatus of claim **1** wherein said support structure comprises a mast horizontally placed and a base for mounting said boom.

**3.** The apparatus of claim **1** further comprising a means for moving said horizontal posts up and down relative to said boom.

**4.** The apparatus of claim **3** further comprising air springs attached between said support structure and said first horizontal post to limit vertical movement of said horizontal posts.

**5.** The apparatus of claim **1** wherein said boom is connected to said support structure with a ball joint connection.

**6.** The apparatus of claim **1** further comprising a second crank arm with elbows where individual spools are placed at

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each elbow and wands extend from each said spool where said one end of said second crank arm is connected to said first horizontal post.

**7.** The apparatus of claim **6** further comprising a means for rotating said second crank arm axially.

**8.** The apparatus of claim **1** wherein a second boom with said horizontal posts, said crank arm, said spools, and said wands is placed adjacent to said first boom wherein each said boom is operable to be independently positioned to dislodge produce from said trees on opposite sides of said apparatus.

**9.** The apparatus of claim **6** wherein a second boom with said horizontal posts, said crank arms, said spools and said wands is placed adjacent to said first boom wherein each said boom is operable to be independently positioned to dislodge produce from said trees on opposite sides of said apparatus.

**10.** A harvesting apparatus for dislodging produce from trees in a grove, said apparatus comprising:

- a propulsion vehicle;
- a support structure attached to said vehicle;
- a collection conveyor attached to said support structure;
- telescoping side conveyors attached to adjacent sides of said collection conveyor;
- means to extend said telescoping side conveyors to a greater length and retract to a lesser length;
- a boom vertically placed where a first end is connected to said support structure;
- means to position a second distant end of said boom radially from said first end;
- horizontal posts slidably connected to said boom wherein a first post is positioned above a second post;
- a lifting means for raising and lowering said horizontal posts;
- crank arm rotatably connected between said horizontal posts where said crank arm has a plurality of elbows;
- spools with individual holes at each center where said crank arm fits through said holes and each individual spool is located at each said elbow whereby said spools are free to rotate axially;
- a plurality of wands axially attached to each said spool equal spaced around each said spool; and
- a means for rotating said crank arm about its axis.

**11.** The apparatus of claim **10** further comprising a produce storage bin disposed proximate to said conveyor.

**12.** The apparatus of claim **10** further comprising a means to raise said telescoping side conveyors to a vertical position and to lower to a horizontal position and to any position there between.

**13.** The apparatus of claim **10** wherein said support structure comprises a mast horizontally placed and a base for mounting said boom.

**14.** The apparatus of claim **10** wherein said collection conveyor is segmented wherein a first segment, closest to said vehicle, is horizontal, a second segment is angled upward, and a third segment is horizontal at a higher elevation than said first segment.

**15.** The apparatus of claim **10** further comprising a means to lower and raise said third segment of said collection conveyor to fit a storage bin.

**16.** The apparatus of claim **10** further comprising a second crank arm with spools at each elbow and wands extending from said each spool where said one end of said second crank arm is connected to said first horizontal post.

**17.** The apparatus of claim **16** further comprising a means for rotating said second crank arm axially.

18. The apparatus of claim 10 wherein a second boom with said horizontal posts, crank arm, said spools and said wands is placed adjacent to a first boom wherein each said boom is operable to be independently positioned to optimally dislodge produce from said trees on opposite sides of said apparatus. 5

19. The apparatus of claim 16 wherein a second boom with said horizontal posts, said crank arms, said spools and said wands is placed adjacent to a first boom wherein each said boom is operable to be independently positioned to optimally dislodge produce from said trees on opposite sides of said apparatus. 10

20. The apparatus of claim 10 further comprising air springs placed between said boom and said support structure to limit vertical movement of said horizontal posts. 15

21. A method for dislodging produce from a grove of trees comprising:

moving a harvesting apparatus though a path between adjacent rows of trees in said grove;

providing crank arms having plurality of freely rotatable spools; 20

providing a plurality of wands axially extending from said spool;

placing wands into canopies of said trees in said adjacent rooms;

providing a mechanism for axially rotating said crank arms while moving said apparatus through said path; and

dislodging fruit from said trees.

22. The method of claim 21 further comprising providing mechanism for moving said crank arms up and down while moving said apparatus through said path.

23. The method of claim 21 further comprising catching said produce with a collection conveyer and telescoping side conveyors.

24. The method of claim 23 further comprising transporting said produce to a storage bin.

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